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# SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT I, Hajime Hasegawa, a citizen of Japan residing at Kawasaki-shi, Kanagawa, Japan have invented certain new and useful improvements in

MOBILE COMMUNICATION SYSTEM ENABLING EFFICIENT USE OF  
SMALL-ZONE BASE STATIONS

of which the following is a specification : -

1 TITLE OF THE INVENTION

MOBILE COMMUNICATION SYSTEM ENABLING  
EFFICIENT USE OF SMALL-ZONE BASE STATIONS

5 BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to mobile communication systems and mobile station apparatuses, and, more particularly, to a mobile communication system in which a radio zone where a mobile station is to enter a wait state is determined by the electric field intensity of a received radio wave that arrives from a radio base station, and to a mobile station apparatus that receives communication service by accessing such a mobile communication system.

The present invention also relates to a mobile communication system wherein a mobile station selects a base station to which a request for a message channel is to be issued, based on announcement information from the base station.

2. Description of the Related Art

Recently, a variety of mobile stations including an automobile mobile station and a portable mobile station access a mobile communication system. With a competition between a plurality of carriers as a background, the number of mobile stations is increasing.

A mobile communication system may have a large-zone construction in which a base station covers a relatively wide service area or a small-zone construction in which a plurality of base stations cover a service area.

In a mobile communication system, radio base stations operated on a small transmission power and forming microcells or picocells are provided at the center of a big city characterized by a

Radio base stations operated on a small transmission power are also provided in an underground passage and a tunnel in order to enlarge a radio zone sufficiently to eliminate a dead zone.

Referring to Fig. 1, radio base stations  $61_1$  and  $61_2$  form adjacent radio zones  $62_1$  and  $62_2$ , respectively. In the radio zone  $62_1$ , a radio base station  $61_3$  forming a microcell 63 and a radio base station  $61_4$  forming a picocell 64 are provided so as to form a multilayer. Mobile stations  $65_1 - 65_N$  are located movable in the radio zones  $62_1$  and  $62_2$ , the microcell 63 and the picocell 64.

Since the radio base stations 61<sub>2</sub> - 61<sub>4</sub> have the same construction as the radio base station 61<sub>1</sub>, the corresponding elements are designated by using suffixes 2 - 4 in the description below, and the illustration and description thereof are omitted.

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Since the construction of the mobile stations 65<sub>2</sub> - 65 is the same as the mobile station 65<sub>1</sub>, the corresponding elements are designated by using suffixes 2 - N in the description below, and the illustration and description thereof are omitted.

25           In addition to the wait enabled level  
and the wait disabled level, the announcement  
information also includes a message type identifying  
transmitted information as the announcement  
information, a mobile station transmission power  
30 specification specifying a transmission power of the  
mobile station, a location code indicating a location  
of the radio zone (service area), and the like.  
However, the information items other than the wait  
enabled level and the wait disabled level does not  
35 have to do with the present invention, and the  
description thereof is omitted.

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25                   When the control unit 77<sub>1</sub> has completed  
a series of the above-described processes  
(hereinafter, referred to as a measurement process)  
for all the control channels registered in the control  
channel table, the control unit 77<sub>1</sub> determines whether  
30 or not the candidate zone register stores any control  
channel ((4) of Fig. 3). If an affirmative answer is  
given, the control unit 77<sub>1</sub> sorts the entries in the  
candidate zone register according to the ascending  
order of the electric field intensity ((5) of Fig. 3).

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1 information via the individual control channels  
registered in the candidate zone register ((6) of Fig.  
3). The control unit  $77_1$  measures the electric field  
intensity again ((7) of Fig. 3). Further, the control  
5 unit  $77_1$  compares the electric field intensity  $L_2$  and  
the wait enabled level  $L_{th}$  included in the  
announcement information ((8) of Fig. 3). When the  
former is lower in level than the latter, a similar  
comparison is conducted for the other control channels  
10 registered in the candidate zone register ((9) of Fig.  
3). Hereinafter, a series of processes performed  
subsequent to the measurement process is referred to  
as a zone determination process. The control unit  $77_1$   
restarts the measurement process when the electric  
15 field intensity is found to be below the wait enabled  
level  $L_{th}$  for all the control channels subjected to  
the comparison ((10) of Fig. 3).

If the electric intensity field of any  
of the control channels is found to be equal to or  
20 exceeds the wait enabled level, the control unit  $77_1$   
establishes that control channel as a control channel  
for the radio zone in which the mobile station is to  
register its location, issues a call and receives an  
incoming call ((11) of Fig. 3). Thereafter, the  
25 control unit  $77_1$  enter a wait state ((12) of Fig. 3).

The operations relating to registering  
of a location, issuing of a call or receiving of an  
incoming call performed by the mobile station  $65_1$  and  
the radio base station  $61_1$  are not directly related to  
30 the present invention, and the description thereof  
will be omitted below.

The operation performed by the radio  
base stations  $61_2 - 61_4$  is the same as the above-  
described operation of the radio base station  $61_1$ , and  
35 the description thereof is omitted. Also, the  
operation performed by the mobile stations  $65_2 - 65_N$   
is the same as the above-described operation of the

When the propagation loss of the radio wave that arrives at the mobile station 65<sub>1</sub> from the radio base station 61<sub>1</sub> increases due to the propagation characteristic of the radio transmission channel varying depending on the speed of the mobile station mobile station 65<sub>1</sub> and the path of the movement, the mobile station 65<sub>1</sub> may leave a zone when it is not necessary and performs the measurement process. Even when a call originated in the mobile station 65<sub>1</sub> becomes a successful call so that a conversation is established without the mobile station 65<sub>1</sub> leaving the zone, the speech quality may be dropped if there is a large propagation loss, with the result that switching of message channels occur too frequently during the conversation.

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1 picocell 64 is provided in order to serve the dead  
area located inside the radio zone 62<sub>1</sub>, the mobile  
station 65<sub>1</sub> may be set up for a wait in a radio zone  
located outside the cell (the microcell 63 or the  
5 picocell 64) in which the mobile station 65<sub>1</sub> is  
actually located. In this case, the microcell 63 or  
the picocell 64 remain unused so that the dead area is  
not efficiently served, a first aspect of the problem  
with the conventional mobile communication system.

10 A description will now be given, with  
reference to Fig. 5, of the flow of call origination  
operation in the conventional mobile communication  
system, in order to explain a second aspect of the  
problem with the conventional mobile communication  
15 system. In the following explanation of the second  
aspect, the PDC mobile communication system employed  
primarily in Japan is assumed.

In the conventional mobile  
communication system, when the user of a mobile  
20 station turns the power on (ST701), the mobile station  
measures a reception level of a perch channel provided  
for a base station (ST702). A perch channel is a term  
used in the PDC mobile communication system to refer  
to a channel provided for each of the base stations to  
25 allow a mobile station to determine a reception level  
with respect to the base station. In the PDC system,  
a perch channel is mainly used to transmit  
announcement information from the base station to the  
mobile station. The claims refer to a perch channel  
30 as a reception-level determining channel. If it is  
determined that the reception level exceeds a  
predetermined level (YES in ST703), the mobile station  
sorts the perch channels according to the ascending  
order of reception levels and stores the perch  
35 channels and the associated reception levels in a  
memory provided in the mobile station (ST704). A  
determination is then made as to whether the reception



1 levels in all the perch channels have been measured  
(ST705).

5 If no perch channels and associated  
reception levels are stored in the memory (NO in  
S706), the mobile station displays an out-of-the-zone  
message in a display device (S707). When perch  
channels and associated reception levels are stored in  
the memory (YES in S706), the mobile station measures  
the reception level in the perch channel having the  
10 highest reception level according to the memory. If  
it is determined that the measured reception level  
exceeds a wait enabled level contained in the  
announcement information from the base station, the  
mobile stations is set up for a wait in the base  
15 station providing the highest reception level (S708).

The mobile station in a wait state  
sends a call request to the base station in which it  
is set up for a wait (S709). The mobile station  
notifies the base station of the perch channel codes  
20 and the reception levels provided by the base stations  
other than the notified base station.

If the level of reception from the  
mobile station issuing the request exceeds a  
predetermined level that enables assigning of a  
25 message channel (YES in S710), and if there is an  
unused message channel (YES in S711), the base station  
receiving the request from the mobile station assigns  
a message channel to the requesting mobile station  
(S712). If the level of reception from the mobile  
30 station is below the predetermined level (NO in S710),  
or if there is no unused message channel (NO in S711),  
the base station receiving the request refers to the  
reception levels of the adjacent base stations  
reported by the mobile station and designates one of  
35 the adjacent base stations as a base station for the  
requesting mobile station (S713).

The mobile station that receives, from

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35 However, a problem with the conventional mobile communication system is that the mobile station requests a message channel from the base station A providing a higher reception level than the base station B instead of requesting it from the

1 base station B provided to handle an increased local  
traffic, with the result that the base station B  
remains unused to handle call originating or call  
incoming in the mobile station.

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SUMMARY OF THE INVENTION

Accordingly, a general object of the  
present invention is to provide a mobile communication  
system and a mobile station apparatus in which the  
10 aforementioned problems of the conventional system are  
eliminated.

Another and more specific object of the  
present invention is to provide a mobile communication  
system and a mobile station apparatus in which a radio  
15 base station adapts itself to a dynamically  
established traffic distribution, or in which a mobile  
station can most successfully enter a radio zone in  
which it is actually located so as to be set up for a  
wait therein.

20 Still another object of the present  
invention is to assign order of priority to a  
plurality of base stations constituting a mobile  
communication system so that a mobile station requests  
a message channel from a base station having a higher  
25 priority than others in order to start communicating  
via that base station.

Fig. 6 is a block diagram of a mobile  
communication system according to claim 1 of the  
present invention. The mobile communication system  
30 according to claim 1 comprises a plurality of radio  
base stations  $1_1 - 1_N$  forming respective radio zones  
and effecting a radio channel setting control in  
accordance with a predetermined procedure, and a  
mobile station 2 selecting, as a wait zone, one of the  
35 radio zones that satisfies a criteria demanded by the  
predetermined procedure, and receiving communication  
service via the selected wait zone. Each of the radio

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1 base stations  $1_1 - 1_N$  comprises a traffic control unit  
3 for setting a traffic distribution for the plurality  
of radio zones, and an announcing unit 4 for  
generating announcement information including the  
5 order of priority assigned to the plurality of radio  
zones, the order of priority being assigned in  
accordance with a probability density given to each of  
the plurality of radio zones under the distribution  
set by the traffic control unit 3, and for  
10 transmitting the announcement information to the radio  
zone formed by the radio station to which the  
announcing unit 4 belongs. The mobile station 2  
comprises an announcement information receiving unit 5  
for receiving the announcement information transmitted  
15 by the announcing unit 4 in accordance with the  
predetermined procedure, and a wait control unit 6 for  
selecting one of the radio zones as a wait zone, the  
radio zone to which a highest priority is assigned  
being a first candidate for selection by the wait  
20 control unit 6.

Fig. 7 shows a mobile communication  
system according to claim 2 of the present invention.  
The mobile communication system according to claim 2  
comprises: a plurality of radio base stations  $11_1 -$   
25  $11_N$  forming one or a plurality of radio zones and one  
or a plurality of small-scale radio zones, resulting  
in a hierarchy of overlapping radio zones, and  
effecting a radio channel setting control in  
accordance with a predetermined procedure; and a  
30 mobile station 12 accessing one of the radio zones  
formed by the respective one of the plurality of radio  
base stations  $11_1 - 11_N$ , in accordance with a  
predetermined procedure, and receiving communication  
service via the accessed radio zone. Each of the  
35 plurality of radio base stations  $11_1 - 11_N$  comprises  
an announcing unit 13 for transmitting announcement  
information which includes identification information

1 for identifying radio channels assigned to respective  
radio zones and small-scale radio zones, via the radio  
channel assigned to the radio zone formed by the radio  
base station to which the announcing unit 13 belongs,  
5 the identification information being arranged in the  
announcement information so as to correspond to the  
hierarchy of overlapping radio zones. The mobile  
station 12 comprises: an announcement information  
receiving unit 14a for receiving the announcement  
10 information transmitted by the announcing unit 13a, in  
accordance with the procedure for radio channel  
setting control; a measuring unit 15a for measuring an  
electric field intensity for the radio channel  
corresponding to the identification information  
15 included in the announcement information received by  
the announcement information receiving unit 14a; and a  
wait control unit 16a for comparing an electric field  
intensity measured by the measuring unit 15a with a  
preset threshold level, and designating a radio zone  
20 to which the radio channel lowest in the hierarchy is  
assigned as a wait zone in which to receive the  
communication service, on the condition that the  
electric field intensity measured by the measuring  
unit 15a exceeds the preset threshold level.

25 The mobile communication system  
according to claim 3 comprises: a plurality of radio  
base stations  $11_1 - 11_N$  forming one or a plurality of  
radio zones and one or a plurality of small-scale  
radio zones, resulting in a hierarchy of overlapping  
30 zones, and effecting a radio channel setting control  
in accordance with a predetermined procedure; and a  
mobile station 12 accessing one of the radio zones  
formed by the respective one of the plurality of radio  
base stations  $11_1 - 11_N$ , in accordance with a  
35 predetermined procedure, and receiving communication  
service via the accessed radio zone. Each of the  
plurality of radio base stations  $11_1 - 11_N$  comprises



1 predetermined procedure, and receiving communication  
service via the accessed radio zone. Each of the  
plurality of radio base stations  $11_1 - 11_N$  comprises  
an announcing unit 13b for transmitting announcement  
5 information which includes identification information  
for identifying radio channels for the one or the  
plurality of radio zones and the one or the plurality  
of small-scale radio zones, via the radio channel  
assigned to the radio zone formed by the radio base  
10 station to which the announcing unit 13b belongs, the  
identification information being arranged in the  
announcement information according to respective  
positions in the hierarchy of overlapping zones. The  
mobile station 12 comprises: an announcement  
15 information receiving unit 14b for receiving the  
announcement information transmitted by the announcing  
unit 13b, in accordance with the procedure for radio  
channel setting control; a measuring unit 15b for  
measuring an electric field intensity for the radio  
20 channel corresponding to the identification  
information included in the announcement information  
received by the announcement information receiving  
unit 14b; and a wait control unit 16b for comparing an  
electric field intensity measured by the measuring  
25 unit 15b with a preset threshold level, and  
designating one of the radio channels, which is  
assigned to the radio zone lowest in the hierarchy and  
for which the control unit 16b has determined that the  
electric field intensity measured by the measuring  
30 unit 15b exceeds the preset threshold level, as a  
radio channel via which to receive the communication  
service.

The mobile communication system  
according to claim 5 comprises: a plurality of radio  
35 base stations  $11_1 - 11_N$  forming one or a plurality of  
radio zones and one or a plurality of small-scale  
radio zones, resulting in a hierarchy of overlapping

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The mobile communication system according to claim 7 comprises: a plurality of radio base stations  $11_1 - 11_N$  forming one or a plurality of radio zones and one or a plurality of small-scale radio zones, resulting in a hierarchy of overlapping zones, and effecting a radio channel setting control in accordance with a predetermined procedure; and a mobile station 12 accessing one of the radio zones formed by the respective one of the plurality of radio base stations  $11_1 - 11_N$ , in accordance with a predetermined procedure, and receiving communication service via the accessed radio zone. Each of the plurality of radio base stations  $11_1 - 11_N$  comprises an announcing unit 13e for transmitting announcement information which includes first identification information for identifying a radio channel assigned to a radio zone formed by the radio base station to which the announcing unit 13e belongs, as well as including second identification information identifying the radio zones and the small-scale radio zones which overlap the radio zone formed by the radio base station to which the announcing unit 13e belongs, over the radio zone formed by the radio base station to which the announcing unit 13e belongs, the second identification information being arranged in the announcement information according to respective positions in the hierarchy of overlapping zones. The

1 mobile station 12 comprises: an announcement  
information receiving unit 14e for receiving the  
announcement information transmitted by the announcing  
unit 13e, in accordance with the procedure for radio  
5 channel setting control; a measuring unit 15e for  
measuring an electric field intensity for the radio  
zone corresponding to the identification information  
included in the announcement information received by  
the announcement information receiving unit 14e; and a  
10 wait control unit 16e for comparing an electric field  
intensity measured by the measuring unit 15e with a  
preset threshold level, determining the radio zone  
corresponding to the radio channel which is identified  
by the associated second identification information,  
15 if available, to have a lowest hierarchical order, and  
designating the determined radio zone as a wait zone  
in which to receive the communication service on the  
condition that the electric field intensity measured  
by the measuring unit 15e exceeds the threshold level.

20           The mobile communication system  
according to claim 8 comprises: a plurality of radio  
base stations  $11_1 - 11_N$  forming one or a plurality of  
radio zones and one or a plurality of small-scale  
radio zones, resulting in a hierarchy of overlapping  
25 zones, and effecting a radio channel setting control  
in accordance with a predetermined procedure; and a  
mobile station 12 accessing one of the radio zones  
formed by the respective one of the plurality of radio  
base stations  $11_1 - 11_N$ , in accordance with a  
30 predetermined procedure, and receiving communication  
service via the accessed radio zone. Each of the  
plurality of radio base stations  $11_1 - 11_N$  comprises  
an announcing unit 13f for transmitting announcement  
information which includes a hierarchical (equal or  
35 subordinate) order of the radio zone formed by the  
radio base station to which the announcing unit 13f  
belongs with respect to the overlapping radio zones

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1 formed by the respective one of the plurality of radio  
base stations  $11_1 - 11_N$ , in accordance with a  
predetermined procedure, and receiving communication  
service via the accessed radio zone. Each of the  
5 plurality of radio base stations  $11_1 - 11_N$  comprises  
an announcing unit 13g for transmitting announcement  
information which includes a hierarchical (equal or  
subordinate) order of the radio zone formed by the  
radio base station to which the announcing unit 13g  
10 belongs with respect to the overlapping radio zones  
and small-scale radio zones, and which also includes  
identification information for identifying the radio  
zone formed by the radio base station to which the  
announcing unit 13g belongs and the overlapping radio  
15 zones and small-scale radio zones, over the radio zone  
formed by the radio base station to which the  
announcing unit 13g belongs. The mobile station 12  
comprises: an announcement information receiving unit  
14g for receiving the announcement information  
20 transmitted by the announcing unit 13g, in accordance  
with the procedure for radio channel setting control,  
for extracting the identification information from the  
announcement information, and for determining the  
hierarchy of the radio zones corresponding to the  
25 identification information; a measuring unit 15g for  
measuring an electric field intensity for the radio  
zone corresponding to the identification information  
extracted by the announcement information receiving  
unit 14g; and a wait control unit 16g for comparing an  
30 electric field intensity measured by the measuring  
unit 15g with a preset threshold level, and  
designating a radio zone lowest in the hierarchy  
determined by the announcement information receiving  
unit 14g as a wait zone in which to receive the  
35 communication service, on the condition that the  
electric field intensity measured by the measuring  
unit 15g for the radio zone lowest in the hierarchy

The announcing unit of the mobile communication system according to claim 10 comprises a unit for adding, in the announcement information, 5 preset threshold values individually provided for the radio zone formed by the radio base station to which the announcing unit belongs and the overlapping radio zones and small-scale radio zones, resulting in a hierarchy that corresponds to the hierarchy of 10 overlapping zones. The wait control unit 16 employs the threshold values added to the announcement information by the announcing unit in making comparisons with the electric field intensity.

The announcing unit of the mobile communication system according to claim 12 comprises a unit for adding relative values indicating the preset threshold values for the radio zone formed by the radio base station to which the announcing unit belongs and the overlapping radio zones and small-scale radio zones, in the form of differences with



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1 station A in selecting a base station from which to  
request a message channel. Therefore, the mobile  
station requests a message channel from the base  
station B in accordance with the order of priority  
5 included in the announcement information from the base  
station A.

Since the mobile station requests a  
message channel from the base station B instead of the  
base station A providing a higher reception level, the  
10 base station B can be used efficiently to handle call  
originating and call incoming in the mobile station.

The mobile station according to claim  
18 further comprises: announcement information  
receiving means for receiving the announcement  
15 information including the order of priority of said  
plurality of base stations and transmitted from said  
plurality of base stations; and transmission means for  
issuing a request for a message channel to the base  
station selected by said control means.

20 According to this aspect of the present  
invention, the announcement information receiving  
means of the mobile station receives the announcement  
information including the order of priority of the  
base stations from, for example, the base station A  
25 and the base station B as shown in Fig. 31. The  
transmission means of the mobile station transmits a  
request for a message channel from a base station  
selected by the control means. For example, the  
mobile station may send the request to the base  
30 station B having the highest priority.

The mobile station according to claim  
19 further comprises: storage means for storing the  
announcement information; measuring means for  
measuring a reception level in reception-level  
35 determining channels in a descending order of priority  
of said plurality of base stations, based on the  
announcement information stored in said storage means

1 and including the order of priority and based on  
information relating to the reception-level  
determining channels.

5 According to this aspect of the present  
invention, the memory means of the mobile station  
stores the announcement information received by the  
announcement information receiving means from, for  
example, the base station A and the base station B as  
shown in Fig. 31 and including the order of priority  
10 of the base stations. Measurement of the reception  
level by the measuring means starts with the base  
station B having the highest priority, based on the  
order of priority of the base stations A and B stored  
in the storing means and the information relating to  
15 the perch channel corresponding to the respective base  
stations. The measuring means notifies the control  
means of the reception level.

Therefore, the mobile station stores  
the order of priority of the base stations included in  
20 the announcement information received by the  
announcement information receiving means and notifies  
the control means of the reception level so that  
selection can be made on the base station to which a  
request for a message channel is to be issued. In  
25 this way, the control means is able to select the base  
station B to which the request should be sent.

The control means according to claim 20  
includes determining means for determining whether the  
reception level in a reception-level determining  
30 channel is equal to or exceeds a predetermined level  
that enables a request for a message channel.

According to this aspect of the present  
invention, the control means of the mobile station can  
determine whether the reception level of the perch  
35 channel of, for example, the base station A or the  
base station B as shown in Fig. 31 is equal to or  
exceeds a predetermined level.

1           The announcing means according to claim  
21 includes first arranging means for ordering the  
announcement information so as to arrange information  
relating to reception-level determining channels in a  
5           descending order of priority.

          According to this aspect of the present  
invention, the announcing means of, for example, the  
base station A as shown Fig. 31 can order the  
announcement information such that information  
10          relating to the perch channel of the base station A  
and that of the base station B are arranged in the  
order of priority.

          The announcing means according to claim  
22 includes second arranging means for ordering the  
15          announcement information so as to couple information  
relating to each reception-level determining channel  
to an order of priority associated therewith.

          According to this aspect of the present  
invention, the announcing means of, for example, the  
20          base station A as shown in Fig. 31 can order the  
announcement information such that information  
relating to the perch channel of the base station A is  
coupled to the priority assigned thereto and  
information relating to the perch channel of the base  
25          station B is coupled to the priority assigned thereto.

          The transmission means according to  
claim 23 includes first transmission means for issuing  
a request for a message channel to the base station  
selected by the control means when a call is  
30          originated.

          According to this aspect of the present  
invention, the control means of the mobile station as  
shown in Fig. 31 can select the base station B  
assigned the highest priority when the mobile station  
35          originates a call, so that the transmission means can  
request a message channel from the base station B.

          The transmission means according to



The mobile station according to claim 27 comprises: announcement information receiving means for receiving, from said plurality of base stations, the announcement information including the order of priority of said plurality of base stations; and transmission means for transmitting a request for a message channel to the base station selected by said control means.

The mobile station according to claim 28 comprises: storage means for storing the announcement information; measuring means for measuring a reception level in reception-level determining channels in a descending order of priority of said plurality of base stations, based on the announcement information stored in said storage means and including the order of priority and based on information relating to the reception-level determining channels.

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A mobile communication system as shown in Fig. 31 is assumed. The base station A forms a relatively large service area (zone) and a base station B having a smaller transmission power than the

According to this aspect of the present invention, the announcing means of, for example, the  
30 base station A as shown in Fig. 31 can order the announcement information such that information relating to the perch channel of the base station A is coupled to the priority assigned thereto and information relating to the perch channel of the base  
35 station B is coupled to the priority assigned thereto.

### BRIEF DESCRIPTION OF THE DRAWINGS



1           Other objects and further features of  
the present invention will be apparent from the  
following detailed description when read in  
conjunction with the accompanying drawings, in which:

5           Fig. 1 shows a construction of a  
conventional mobile communication system;

Fig. 2 shows a construction of  
conventional announcement information;

10          Fig. 3 is a flowchart of a conventional  
operation;

Fig. 4 illustrates a problem with the  
conventional mobile communication system;

Fig. 5 is a flowchart showing the  
conventional call origination operation;

15          Fig. 6 is a block diagram of a mobile  
communication system according to the invention  
described in claim 1;

Fig. 7 is a block diagram showing a  
principle of the invention described in claims 2 - 15;

20          Fig. 8 is a block diagram showing a  
principle of the invention described in claim 16;

Fig. 9 is a flowchart of an operation  
of a system according to the invention described in  
claims 2, 3, 14 - 16;

25          Fig. 10 shows a format of announcement  
information according to an embodiment that  
corresponds to the invention described in claims 2 and  
3;

30          Fig. 11 is a flowchart of an operation  
according to an embodiment that corresponds to the  
invention described in claims 4 - 9, 14 and 15;

35          Fig. 12 shows a format of announcement  
information according to an embodiment that  
corresponds to the invention described in claims 4 -  
7;

Fig. 13 shows a format of announcement  
information according to an embodiment that

1 corresponds to the invention described in claims 8 and  
9;

Fig. 14 is a flowchart of an operation  
according to an embodiment that corresponds the  
5 invention described in claims 10, 14 and 15;

Fig. 15 shows a format of announcement  
information according to an embodiment that  
corresponds to the invention described in claim 10;

Fig. 16 is a flowchart of an operation  
10 according to an embodiment that corresponds to the  
invention described in claims 11, 12, 14 and 15;

Fig. 17 shows announcement information  
according to an embodiment that corresponds to the  
invention described in claims 11 and 12;

15 Fig. 18 is a flowchart of an operation  
according to an embodiment that corresponds to the  
invention described in claims 13 - 15;

Fig. 19 shows a mobile communication  
system directed to resolving the problem with the  
20 conventional message channel assigning operation;

Fig. 20 shows a mobile communication  
system to which the present invention is applied;

Fig. 21A shows how the announcement  
information is delivered;

25 Fig. 21B shows the principle of the  
flow of the call origination operation according to  
the present invention;

Fig. 22 shows a format of the  
announcement information according to the present  
30 invention;

Fig. 23 shows another format of the  
announcement information according to the present  
invention;

35 Fig. 24 shows still another format of  
the announcement information according to the present  
invention;

Fig. 25 is a flowchart showing the flow

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Fig. 26 shows a sequence of the call origination operation according to the present invention;

Fig. 28 shows the sequence of the call-incoming operation according to the present invention;

Fig. 30 shows the sequence of the recall channel switching operation according to the present invention;

Fig. 32 shows a hardware construction of a base station assumed in the present invention; and

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

35

1 omitted.

The radio base stations  $61_1 - 61_4$  correspond to the radio base stations  $1_1 - 1_N$  shown in Fig. 6, respectively. Each of the radio base stations  $1_1 - 1_N$  includes the respective traffic control unit 3 and the announcing unit 4. The mobile stations  $65_1 - 65_N$  correspond to the mobile station 2 which includes the announcement information receiving unit 5 and the wait control unit 6.

10 A description will now be given, with reference to Fig. 1, of the operation of the system that corresponds to the invention described in claim 1.

Each of the base station control devices  $69_1 - 69_4$  of the radio base stations  $61_1 - 61_4$ , respectively, maintains a data base (not shown). Such a data base assigns a weight to each of the radio base stations  $61_1 - 61_4$  so as to arrange the radio base stations  $61_1 - 61_4$  in the order of priority. The weight is determined by a condition such as the operating mode and the current traffic. The operating mode could include the day of the week, the time zone of the day and the like.

Each of the base station control devices  $69_1 - 69_4$  also monitors calls originated in mobile stations located in a radio zone formed by the respective base station, so that the traffic in that radio zone can be measured. The measured traffic is reported to the other base stations via a communication link (not shown).

Further, each of the base station control devices  $69_1 - 69_4$  refers to the above-mentioned data base against the traffic measured locally, the traffic reported by the other base stations, and the day of the week and the time zone, so as to determine a combination of weights suitable for the combination of the ongoing traffic. Each of

1 the base station control devices  $69_1 - 69_4$  then  
incorporates the determined combination in the  
announcement information in relation to the respective  
radio zones  $62_1 - 62_4$  (or the radio base stations  $61_1$   
5 -  $61_4$ ). The announcement information is transmitted  
via the transmission and reception units  $68_1 - 68_4$ ,  
the common antenna equipment units  $67_1 - 67_4$  and the  
antennas  $66_1 - 66_4$ .

The control unit  $77_1$  of the mobile  
10 station  $65_1$  effects a measurement process and a zone  
determination process as in the conventional system.  
Given that there are a plurality of candidate radio  
zones which the mobile station  $65_1$  may enter, the  
radio zone to which the greatest weight is assigned in  
15 the announcement information is selected as the first  
candidate zone for entry so that the control unit  $77_1$   
can enter a wait state.

Thus, according to the embodiment that  
corresponds to the invention described in claim 1, the  
distribution of the mobile stations set up for a wait  
20 in respective radio zones can be varied dynamically so  
as to be adapted for the operating condition and the  
operating mode of the radio base stations. Therefore,  
maintenance and operating requirements are flexibly  
25 met and the resources such as the radio base stations  
and the radio frequencies are effectively utilized.

In the above-described embodiments, the  
weights are determined by the traffic distribution in  
the radio zones, the day of the week and the time  
30 zone. However, the weight may be appropriately  
provided in correspondence with events detected in the  
process of the monitoring control and the radio  
channel setting control effected by the radio base  
stations. Such events may be various failures and  
35 releases therefrom, or congestions in radio channels.

Fig. 8 is a flowchart of an operation  
of the mobile communication system according to

The inventive feature of the embodiments that correspond to the invention described in claims 2, 3 and 14 - 16 consists in the constitution of the announcement information sent by the base station control devices 69<sub>1</sub> - 69<sub>4</sub> of the radio base stations 61<sub>1</sub> - 61<sub>4</sub> to the control channel, and in the procedure of radio channel setting control process effected by the control units 77<sub>1</sub> - 77<sub>N</sub> of the mobile stations 65<sub>1</sub> - 65<sub>N</sub>, respectively, in accordance with the announcement information. The hardware configuration of the embodiments that correspond to the invention described in claims 2, 3 and 14 - 16 is the same as that of the conventional system shown in Fig. 1, and the description thereof is omitted.

The radio base stations 61<sub>1</sub> - 61<sub>4</sub> correspond to radio base stations 11<sub>1</sub> - 11<sub>N</sub> which include announcing units 13 and 13a - 13g, respectively. The mobile stations 65<sub>1</sub> - 65<sub>N</sub> correspond to a mobile station 12 which includes one of announcing information receiving units 14 and 14a - 14g (in the case of claim 2) or an announcing information receiving unit 21 (in the case of claim 16). The mobile station 12 also includes one of measuring units 15 and 15a - 15g, one of wait control units 16 and 16a - 16g, an entry determining unit 17, a wait unit 23, and a communication control unit 25.

A description will now be given of the operation of the system according to embodiments that correspond to the invention described in claims 2, 3 and 16. For the sake of simplicity of the description that follows, it is assumed that the mobile station 65<sub>1</sub> is located in the same location assumed in the description of the related art.

In the absence of a hierarchy of radio zones (hereinafter, referred to as overlap zones)

10           If there are overlap zones, the base  
station control device 69<sub>1</sub> is provided by a control  
station (not shown) with an identification code C<sub>1</sub> for  
a control channel formed by the radio base station 61<sub>1</sub>  
and identification codes C<sub>3</sub> and C<sub>4</sub> for control  
15 channels (hereinafter, referred to as overlap control  
channels) assigned to the microcell 63 and the  
picocell 64 embodying the overlap zones, via the  
communication link 71<sub>1</sub> and the transmission device  
70<sub>1</sub>. As indicated by a hatched area in Fig. 10, the  
20 base station control device 69<sub>1</sub> incorporates, in the  
announcement information, the identification codes C<sub>1</sub>  
and C<sub>3</sub> - C<sub>4</sub> for the control channel and the overlap  
control channels, respectively, such that a series of  
the identification codes C<sub>4</sub>, C<sub>3</sub> and C<sub>1</sub> are arranged  
25 according to respective positions in the hierarchy.  
The wait enabled level and the wait disabled level are  
also included in the announcement information as in  
the conventional system.

39

1 the above-described series of the identification codes  
is included in the announcement information ((1) of  
Fig. 9).

5 If the format of the announcement  
information is found to be the same as the  
conventional format, the control unit  $77_1$  performs the  
zone determination process in accordance with the same  
procedure as observed in the conventional system  
before proceeding to a wait state ((2) of Fig. 9).

10 If the format of the announcement  
information is not found to be the same as the  
conventional format, the control unit  $77_1$  stores the  
series of the identification codes  $C_4$ ,  $C_3$  and  $C_1$  in a  
reserved area (hereinafter, referred to as a selected  
15 candidate zone register) in the main memory ((3) of  
Fig. 9). The control unit  $77_1$  sequentially refers to  
the identification codes  $C_4$ ,  $C_3$  and  $C_1$  and measures  
the electric field intensity  $L_3$  of the overlap control  
channels and the control channel corresponding to the  
20 respective identification codes ((4) of Fig. 9). The  
control unit  $77_1$  then compares the measured electric  
field intensity with the wait enabled level  $L_{th}$   
received in the announcement information via the  
channel subject to the measurement ((5) of Fig. 9).

25 If the electric field  $L_3$  is found to  
exceed the wait enabled level  $L_{th}$ , the control unit  
 $77_1$  retains the relevant identification code in the  
selected candidate zone register. If the opposite is  
the case, the relevant identification code is removed  
30 ((6) of Fig. 9).

When the control unit  $77_1$  has processed  
all the identification codes stored in the candidate  
zone register, a determination is made as to whether  
or not the selected candidate zone register contains  
35 any identification code ((7) of Fig. 9). When the  
determination in (7) gives a negative answer, the  
control unit  $77_1$  performs the zone determination



1 process in accordance with the conventional procedure  
before proceeding to a wait state ((8) of Fig. 9).

When the determination in (7) gives a  
positive answer, the control unit 77<sub>1</sub> designates an  
5 overlap control channel (or a control channel)  
specified by the identification code stored earliest  
in the selected candidate zone register as a control  
channel for a radio zone in which the mobile station  
65<sub>1</sub> is to receive the communication service, and  
10 proceeds to be set up for a wait in the designated  
control channel ((9) of Fig. 9).

Thus, in the system described above,  
the mobile stations 65<sub>1</sub> - 65<sub>N</sub> give a priority to the  
microcell 63 over the radio zone 62<sub>1</sub>, and give a  
15 priority to the picocell 64 over the microcell 63, in  
selecting a wait zone. In contrast with the  
conventional system in which the wait zone is selected  
simply in accordance with the order of electric field  
intensity of the associated control channels, the  
20 embodiments that correspond to the invention described  
in claims 2, 3 and 14 - 16 ensure that the mobile  
station can wait in the most appropriate zone than the  
conventional system.

In the foregoing description, it is  
25 assumed that the mobile stations 65<sub>1</sub> - 65<sub>N</sub> are  
implemented by the mobile station described in claim  
16. However, mobile stations according to different  
embodiments may also be employed.

Fig. 11 is a flowchart of an operation  
30 of the mobile communication system according to  
embodiments that correspond to the invention described  
in claims 4 - 9, 14 and 15.

A description will now be given, with  
reference to Figs. 1 and 11, of the operation of the  
35 system according to embodiments that correspond to  
invention described in claims 4 - 7. For the sake of  
simplicity of the description that follows, it is

1 assumed that the mobile station 65<sub>1</sub> is located in the  
same location assumed in the description of the  
related art.

5 In the absence of overlap zones such as  
a microcell 63, a picocell 64 and the like at  
respective locations in a radio zone formed by the  
radio base station 61<sub>1</sub>, the base station control  
device 69<sub>1</sub> of the radio base station 61<sub>1</sub> transmits the  
announcement information having the same format as  
10 that of the conventional announcement information as  
shown in Fig. 2, via the transmission and reception  
unit 68<sub>1</sub>, the common antenna equipment unit 67<sub>1</sub> and  
the antenna 66<sub>1</sub>.

15 If there are overlap zones, the base  
station control device 69<sub>1</sub> is provided by a control  
station (not shown) with an identification code C<sub>1</sub> for  
a control channel assigned to the radio base station  
61<sub>1</sub>, identification codes C<sub>3</sub> and C<sub>4</sub> for overlap  
control channels assigned to the microcell 63 and the  
20 picocell 64 embodying the overlap zones, and numerals  
P<sub>1</sub>, P<sub>3</sub> and P<sub>4</sub> indicating the hierarchical order of the  
radio zone 62<sub>1</sub>, the microcell 63 and the picocell 64,  
via the communication link 71<sub>1</sub> and the transmission  
device 70<sub>1</sub>. The numerals will be simply referred to  
25 as the order of priority. For the sake of simplicity  
of the description, it is assumed that the radio zone  
62<sub>1</sub> has the order of priority P<sub>1</sub> = 0, the microcell 63  
P<sub>3</sub> = 1 and the picocell 64 P<sub>4</sub> = 2.

30 As indicated by a hatched area in Fig.  
12, the base station control device 69<sub>1</sub> incorporates,  
in the announcement information, the identification  
codes C<sub>1</sub> and C<sub>3</sub> - C<sub>4</sub>, and the orders of priority P<sub>1</sub>,  
P<sub>3</sub> and P<sub>4</sub> such that a resultant series of  
identification information C<sub>1</sub>, P<sub>1</sub>, C<sub>3</sub>, P<sub>3</sub>, C<sub>4</sub> and P<sub>4</sub>  
35 show correspondences between the individual channels  
and the order of priority associated therewith. The  
wait enabled level and the wait disabled level are

The control unit 77<sub>1</sub> of the mobile station 65<sub>1</sub> effects the measurement process and the zone determination process as in the conventional system. In the zone determination process, a determination as to whether the format of the announcement information received via the control channel subject to the measurement of the electric field intensity  $L_2$  is the same as the conventional format shown in Fig. 2 is made, depending on whether the above-described series of the identification information is included in the announcement information ((1) of Fig. 11).

15           If the format of the announcement  
information is found to be the same as the  
conventional format, the control unit 77<sub>1</sub> performs the  
zone determination process in accordance with the same  
procedure as observed in the conventional system  
20 before proceeding to a wait state ((2) of Fig. 11).

If the format of the announcement information is not found to be the same as the conventional format, the control unit 77<sub>1</sub> stores the series of the identification information C<sub>1</sub>, P<sub>1</sub>, C<sub>3</sub>, P<sub>3</sub>, C<sub>4</sub> and P<sub>4</sub> in the selected candidate zone register in the main memory ((3) of Fig. 11). The control unit 77<sub>1</sub> sorts the combinations of the identification codes and the orders of priority stored in the selected candidate zone register, in the ascending order of priority. Once this sorting is done, all the orders of priority are removed from the register, resulting in the series of identification information consisted only of the identification codes being stored in the selected candidate zone register ((a) of Fig. 11).

43

According to the embodiment that corresponds to the invention described in claims 4 - 9, 14 and 15, the series of identification information (C<sub>1</sub>, P<sub>1</sub>, C<sub>3</sub>, P<sub>3</sub>, C<sub>4</sub>, P<sub>4</sub>) stored in the selected candidate zone register is sorted in the ascending order of the priority, and then the identification

1 information consisting only of the identification  
codes are retained in the selected candidate zone  
register. An alternative procedure may be to retain  
the orders of priority in the selected candidate zone  
5 register so that the identification code with the  
highest priority may be referred to in selecting a  
wait zone.

As shown in Fig. 12, according to the  
embodiment that corresponds to the invention described  
10 in claims 4 - 9, 14 and 15, the radio base station  $61_1$   
transmits, as part of the announcement information,  
the order of priority  $P_1$  for the radio zone  $62_1$  in  
relation to the identification code  $C_1$  for the radio  
zone  $62_1$ . However, if the mobile station ( $65_1 - 65_N$ )  
15 is capable of identifying the relative order of  
priority of the radio zone  $62_1$  with respect to other  
radio zones (for example, the microcell 63 and the  
picocell 64), or if it is evident that the mobile  
station ( $65_1 - 65_N$ ) should be set up for a wait in the  
20 radio zone at the top of the hierarchy or the radio  
zone at the bottom thereof, the order of priority may  
not be included in the announcement information.  
Accordingly, the volume of the announcement  
information is reduced so that the system flexibility  
25 with respect to modifications etc. thereof can be  
improved.

A description will now be given, with  
reference to Figs. 1 and 11, of the operation of the  
system according to an embodiment that corresponds to  
30 the invention described in claims 8 and 9. For the  
sake of simplicity of the description that follows, it  
is assumed that the mobile station  $65_1$  is located in  
the same location assumed in the description of the  
related art.

35 In the absence of overlap zones such as  
a microcell 63, a picocell 64 and the like at  
respective locations in a radio zone formed by the

1 radio base station  $61_1$ , the base station control  
device  $69_1$  of the radio base station  $61_1$  transmits the  
announcement information having the same format as  
that of the conventional announcement information as  
5 shown in Fig. 2, via the transmission and reception  
unit  $68_1$ , the common antenna equipment unit  $67_1$  and  
the antenna  $66_1$ .

If there are overlap zones, the base  
station control device  $69_1$  is provided by a control  
10 station (not shown) with an identification code  $C_1$  and  
an associated order of priority  $P_1$  for a control  
channel formed by the radio base station  $61_1$ ,  
identification codes  $C_3$  and  $C_4$  for overlap control  
channels assigned to the microcell 63 and the picocell  
15 64 embodying the overlap zones, the order of the  
identification codes  $C_3$  and  $C_4$  not being related to  
the associated orders of priority. The resultant  
series of identification information  $P_1$ ,  $C_1$ ,  $C_4$  and  $C_3$   
incorporated in the announcement information is  
20 indicated by a hatched area in Fig. 13. The wait  
enabled level and the wait disabled level are also  
included in the announcement information as in the  
conventional system. For the sake of simplicity of  
the description, it is assumed that the order of  
25 priority  $P_1 = 0$ .

The control unit  $77_1$  of the mobile  
station  $65_1$  effects the measurement process and the  
zone determination process as in the conventional  
system. In the zone determination process, a  
30 determination is made as to whether the format of the  
announcement information received via the control  
channel in which the electric field intensity  $L_2$  is  
measured is the same as the conventional format shown  
in Fig. 2, depending on whether the above-described  
35 series of the identification information is included  
in the announcement information ((1) of Fig. 11).

If the format of the announcement

1 information is found to be the same as the  
conventional format, the control unit 77<sub>1</sub> performs the  
zone determination process in accordance with the same  
procedure as observed in the conventional system  
5 before proceeding to a wait state ((2) of Fig. 11).

If the format of the announcement  
information is not found to be the same as the  
conventional format, the control unit 77<sub>1</sub> extracts the  
order of priority P<sub>1</sub> and the identification code C<sub>1</sub>  
10 from the series of identification information P<sub>1</sub>, C<sub>1</sub>,  
C<sub>4</sub> and C<sub>3</sub> and stores the extracted information in the  
selected candidate zone register in the main memory  
((3) of Fig. 11). The control unit 77<sub>1</sub> measures the  
electric field intensity L<sub>2</sub> of the overlap control  
15 channels specified by the identification codes C<sub>4</sub> and  
C<sub>3</sub> and stores the identification codes C<sub>4</sub> and C<sub>3</sub>, and  
the orders of priority thereof in the selected  
candidate zone register. A similar step as above is  
performed in the event that any additional  
20 identification code is received in the form of the  
announcement information (an identification code that  
is repeated is not subject to the above step).

When the identification codes and the  
associated orders of priority for the radio zones that  
25 are candidates for a wait zone have been stored in the  
selected candidate zone register, the control unit 77<sub>1</sub>  
performs the same steps ((a), (4) - (9) of Fig. 11) as  
performed in the embodiment that corresponds to the  
invention described in claims 4 - 7, before proceeding  
30 to a wait state.

According to the embodiment described  
above, the announcement information may not include  
the orders of priority of all the microcells and  
picocells in order for the control unit 77<sub>1</sub> of the  
35 mobile station 65<sub>1</sub> to specify the control channel for  
the radio zone in which the mobile station 65<sub>1</sub> is  
actually located before proceeding to a wait state.

1                   Therefore, an advantage of the  
embodiment that corresponds to the invention described  
in claims 8 and 9 over the embodiment that corresponds  
to the invention described in claims 4 - 7 is that the  
5   transmission efficiency of the control channel is  
increased and flexibility with respect to different  
modes of service is available.

                  While the identification codes in the  
foregoing embodiments are for identifying individual  
10   control channels or overlap control channels, the  
present invention is not limited to such a  
constitution. The mobile station ( $65_1 - 65_N$ ) may use  
alternative identification information (zone  
identification information) for identifying radio  
15   zones (such as the picocell 64, the microcell 63, the  
radio zone  $62_1$ ), instead of control channels  
associated therewith, included in the announcement  
information, in order to determine a radio zone for  
entry.

20                   In the alternative approach described  
above, information specifying overlap control channels  
and control channels that correspond to the zone  
identification information may be stored in the form  
of a table in an area reserved in a main memory of the  
25   control unit  $77_1 - 77_N$ , or may be provided separately  
(for example, as part of the announcement information)  
in accordance with the radio channel setting control  
executed in relation to the radio base stations  $61_1 -$   
 $61_4$ .

30                   Fig. 14 is a flowchart of an operation  
of the mobile communication system according to an  
embodiment that corresponds to the invention described  
in claims 10, 14 and 15.

                  A description will now be given, with  
35   reference to Figs. 1 and 14, of the operation  
according to an embodiment that corresponds to the  
invention described in claim 10. For the sake of



1 simplicity of the description that follows, it is  
assumed that the mobile station 65<sub>1</sub> is located in the  
same location assumed in the description of the  
related art.

5 In the absence of overlap zones at  
respective locations in a radio zone formed by the  
radio base station 61<sub>1</sub>, the base station control  
device 69<sub>1</sub> of the radio base station 61<sub>1</sub> transmits the  
announcement information having the same format as  
10 that of the conventional announcement information as  
shown in Fig. 2, via the transmission and reception  
unit 68<sub>1</sub>, the common antenna equipment unit 67<sub>1</sub> and  
the antenna 66<sub>1</sub>.

If there are overlap zones, the base  
15 station control device 69<sub>1</sub> is provided by a control  
station (not shown) with an identification code C<sub>1</sub> for  
a control channel assigned to the radio base station  
61<sub>1</sub>, identification codes C<sub>3</sub> and C<sub>4</sub> for overlap  
control channels assigned to the microcell 63 and the  
20 picocell 64 embodying the overlap zones, orders of  
priority P<sub>1</sub>, P<sub>3</sub> and P<sub>4</sub> indicating the hierarchical  
order of the radio zone 62<sub>1</sub>, the microcell 63 and the  
picocell 64, wait enabled levels L<sub>th1</sub>, L<sub>th2</sub> and L<sub>th3</sub>  
and the wait disabled levels l<sub>th1</sub>, l<sub>th3</sub> and l<sub>th4</sub>, via  
25 the communication link 71<sub>1</sub> and the transmission device  
70<sub>1</sub>. For the sake of simplicity of the description,  
it is assumed that the radio zone 62<sub>1</sub> has the order of  
priority P<sub>1</sub> = 0, the microcell 63 P<sub>3</sub> = 1 and the  
picocell 64 P<sub>4</sub> = 2.

30 As indicated by a hatched area in Fig.  
15, the base station control device 69<sub>1</sub> incorporates,  
in the announcement information, the orders of  
priority P<sub>1</sub>, P<sub>3</sub> and P<sub>4</sub>, the identification codes C<sub>1</sub>,  
C<sub>3</sub> and C<sub>4</sub>, the wait enabled levels L<sub>th1</sub>, L<sub>th2</sub> and L<sub>th3</sub>  
35 and the wait disabled levels l<sub>th1</sub>, l<sub>th3</sub> and l<sub>th4</sub>,  
resulting in series of identification information (P<sub>1</sub>,  
C<sub>1</sub>, L<sub>th1</sub> and l<sub>th1</sub>) ... (P<sub>4</sub>, C<sub>4</sub>, L<sub>th4</sub> and l<sub>th4</sub>) each

1 corresponding to the radio zone.

The control unit  $77_1$  of the mobile station  $65_1$  effects the measurement process and the zone determination process as in the conventional system. In the zone determination process, a determination as to whether the format of the announcement information received via the control channel subject to the measurement of the electric field intensity  $L_2$  is the same as the conventional format shown in Fig. 2 is made, depending on whether the above-described series of the identification information is included in the announcement information ((1) of Fig. 14).

If the format of the announcement information is found to be the same as the conventional format, the control unit  $77_1$  performs the zone determination process in accordance with the same procedure as observed in the conventional system before proceeding to a wait state ((2) of Fig. 14).

If the format of the announcement information is not found to be the same as the conventional format, the control unit  $77_1$  stores the series of the identification information ( $P_1, C_1, L_{th1}$  and  $l_{th1}$ ) ... ( $P_4, C_4, L_{th4}$  and  $l_{th4}$ ) included in the announcement information in the selected candidate zone register (A) of Fig. 14). The control unit  $77_1$  sorts the combinations of the orders of priority, the identification codes, the wait enabled levels and the wait disabled levels stored in the selected candidate zone register, in the ascending order of priority. Once this sorting is done, all the orders of priority are removed from the register ((a) of Fig. 14), resulting in the series of identification information consisted of the identification codes, the wait enabled levels and the wait disabled levels being stored in the selected candidate zone register.

The control unit  $77_1$  sequentially

1 refers to the identification codes  $C_4$ ,  $C_3$  and  $C_1$ , and  
wait enabled levels  $L_{th4}$ ,  $L_{th3}$  and  $L_{th1}$  arranged in  
the ascending order of priority so as to measure the  
electric field intensity  $L_3$  of the overlap control  
5 channels and the control channel corresponding to the  
respective identification codes ((4) of Fig. 14). The  
control unit  $77_1$  then compares the measured electric  
field intensity with the wait enabled level  $L_{th}$  that  
corresponds to the measured channel ((5) of Fig. 14).

10 When the result of the comparison is  
available, the control unit  $77_1$  then enters a wait  
state in accordance with the same procedure observed  
in the embodiment that corresponds the invention  
described in claim 4. The steps subsequent to (5) of  
15 Fig. 14 are designated by the same reference numerals  
(6) - (9) as the corresponding steps of Fig. 9, and  
the description thereof is omitted.

According to the embodiment that  
corresponds to the invention described in claim 10,  
20 the mobile stations  $65_1 - 65_N$  give a priority to the  
radio zone having a greater order of priority, in  
selecting a wait zone. The threshold level of the  
electric field intensity that serves as a criteria  
associated with each radio zone for selection of the  
25 wait zone can be dynamically (or statically) set under  
the control of the radio base station.

Accordingly, the geographical  
distribution (number) of the mobile stations set up  
for a wait in the radio zones  $62_1$  and  $62_2$ , the  
30 microcell 63 and the picocell 64 can be properly  
established. Also, the hierarchy of radio zones can  
be properly established. As in the embodiment that  
corresponds to the invention described in claim 2, the  
mobile stations  $65_1 - 65_N$  can give a priority to the  
35 microcell 63 over the radio zone  $62_1$  and give a  
priority to the picocell 64 over the microcell 63, in  
selecting a wait zone.

1           While the embodiment described above is  
constructed such that the series of information ( $P_1$ ,  
2            $C_1$ ,  $L_{th1}$  and  $l_{th1}$ ) ... ( $P_4$ ,  $C_4$ ,  $L_{th4}$  and  $l_{th4}$ ) is  
sorted according to the ascending order (the  
5           descending order) of the order of priority, so that  
the identification codes, the wait enabled levels and  
the wait disabled levels are retained in the register,  
the orders of priority may not be removed from the  
register and may be referred to in selecting a wait  
10          zone.

Fig. 16 is a flowchart of an operation  
of a system according to an embodiment that  
corresponds to the invention described in claims 11,  
12, 14 and 15.

15           A description will now be given, with  
reference to Figs. 1 and 16, of an operation of a  
mobile communication system according to an embodiment  
that corresponds to the invention described in claims  
11 and 12.

20           In the absence of overlap zones at  
respective locations in a radio zone formed by the  
radio base station  $61_1$ , the base station control  
device  $69_1$  of the radio base station  $61_1$  transmits the  
announcement information having the same format as  
25          that of the conventional announcement information as  
shown in Fig. 2, via the transmission and reception  
unit  $68_1$ , the common antenna equipment unit  $67_1$  and  
the antenna  $66_1$ .

            If there are overlap zones, the base  
30          station control device  $69_1$  is provided by a control  
station (not shown) with an identification code  $C_1$  for  
a control channel formed by the radio base station  
 $61_1$ , identification codes  $C_3$  and  $C_4$  for overlap  
control channels assigned to the microcell 63 and the  
35          picocell 64 embodying the overlap zones, orders of  
priority  $P_1$ ,  $P_3$  and  $P_4$  indicating the hierarchical  
order of the radio zone  $62_1$ , the microcell 63 and the

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1 picocell 64, corrected values  $\Delta_1$ ,  $\Delta_2$  and  $\Delta_3$  indicating  
the enabled levels in the form of relative levels with  
respect to a predetermined reference level  $L_0$  and the  
wait disabled levels  $l_{th1}$ ,  $l_{th3}$  and  $l_{th4}$ , via the  
5 communication link  $71_1$  and the transmission device  
 $70_1$ . For the sake of simplicity of the description,  
it is assumed that the radio zone  $62_1$  has the order of  
priority  $P_1 = 0$ , the microcell 63  $P_3 = 1$  and the  
picocell 64  $P_4 = 2$ .

10 As indicated by a hatched area in Fig.  
17, the base station control device  $69_1$  incorporates,  
in the announcement information, the identification  
codes  $C_1$ ,  $C_3$  and  $C_4$ , the orders of priority  $P_1$ ,  $P_3$  and  
 $P_4$ , the corrected values  $\Delta_1$ ,  $\Delta_2$  and  $\Delta_3$  and the wait  
15 disabled levels  $l_{th1}$ ,  $l_{th3}$  and  $l_{th4}$ , resulting in  
series of identification information ( $P_1$ ,  $C_1$ ,  $\Delta_1$  and  
 $l_{th1}$ ) ... ( $P_4$ ,  $C_4$ ,  $\Delta_4$  and  $l_{th4}$ ) each corresponding to  
the radio zone.

The control unit  $77_1$  of the mobile  
20 station  $65_1$  effects the measurement process and the  
zone determination process as in the conventional  
system. In the zone determination process, a  
determination as to whether the format of the  
announcement information received via the control  
25 channel subject to the measurement of the electric  
field intensity  $L_2$  is the same as the conventional  
format shown in Fig. 2 is made, depending on whether  
the above-described series of the identification  
information is included in the announcement  
30 information ((1) of Fig. 16). If the format of the  
announcement information is found to be the same as  
the conventional format, the control unit  $77_1$  performs  
the zone determination process in accordance with the  
same procedure as observed in the conventional system  
35 before proceeding to a wait state ((2) of Fig. 16).

If the format of the announcement  
information is not found to be the same as the

1 conventional format, the control unit  $77_1$  stores the  
series of the identification information ( $P_1, C_1, \Delta_1$   
and  $l_{th1}$ ) ... ( $P_4, C_4, \Delta_4$  and  $l_{th4}$ ) included in the  
announcement information in the selected candidate  
5 zone register. The control unit  $77_1$  sorts the  
combinations of the orders of priority, the  
identification codes, the corrected values and the  
wait disabled levels stored in the selected candidate  
zone register, in the ascending order of priority.  
10 Once this sorting is done, all the orders of priority  
are removed from the register, resulting in the series  
of identification information consisted of the  
identification codes, the corrected values and the  
wait disabled levels being stored in the selected  
15 candidate zone register ((A) of Fig. 16).

The control unit  $77_1$  sequentially  
refers to the identification codes  $C_4, C_3$  and  $C_1$ , and  
corrected values  $\Delta_1, \Delta_2$  and  $\Delta_3$  arranged in the  
ascending order of priority so as to measure the  
20 electric field intensity  $L_3$  of the overlap control  
channels and the control channel corresponding to the  
respective identification codes ((4) of Fig. 16). The  
control unit  $77_1$  then compares the measured electric  
field intensity with a sum of the corrected value  $\Delta$   
25 for the measured channel and the reference value  $L_0$   
((5) of Fig. 16).

When the result of the comparison is  
available, the control unit  $77_1$  then enters a wait  
state in accordance with the same procedure observed  
30 in the embodiment that corresponds to the invention  
described in claim 4. The steps subsequent to (5) of  
Fig. 16 are designated by the same reference numerals  
(6) - (9) as the corresponding steps of Fig. 14, and  
the description thereof is omitted.

35 According to the embodiment described  
above, the corrected values smaller than the values of  
the wait enabled levels are included in the

1 announcement information in place of the wait enabled  
levels. The mobile stations  $65_1 - 65_N$  can give a  
priority to the radio zone having a greater order of  
priority, in selecting a wait zone.

5 Accordingly, the transmission  
efficiency of the control channel can be maintained at  
a high level. The geographical distribution (number)  
of the mobile stations set up for a wait in the radio  
zones  $62_1$  and  $62_2$ , the microcell 63 and the picocell  
10 64 can be properly established. Also, the hierarchy  
of radio zones can be properly established.  
The mobile stations  $65_1 - 65_N$  can give a priority to  
the microcell 63 or the picocell 64 over the radio  
zone  $62_1$ , in selecting a wait zone.

15 While the embodiment described above is  
constructed such that the series of information ( $P_1$ ,  
 $C_1$ ,  $\Delta_1$  and  $l_{th1}$ ) ... ( $P_4$ ,  $C_4$ ,  $\Delta_4$  and  $l_{th4}$ ) is sorted  
according to the ascending order (the descending  
order) of the order of priority so that the  
20 identification codes, the corrected values and the  
wait disabled levels are retained in the register, the  
orders of priority may not be removed from the  
register and may be referred to in selecting a wait  
zone.

25 The embodiment described above is  
constructed such that the radio base station transmits  
the corrected values associated with all the  
microcells and picocells formed within the radio zone  
of that radio base station. Alternatively, for  
30 example, the radio base stations each forming the  
radio zone, the microcell or the picocell may transmit  
only the corrected value associated with its own radio  
zone. In such a case, the mobile station is expected  
to perform the determination step ((5) of Fig. 16) by  
35 acquiring the corrected value from the individual  
control channels subject to measurement of the  
electric field intensity.

1           Although no description is given of a  
process related to the wait disabled level in the  
embodiments that correspond to the invention described  
in claims 10 - 12, the wait disabled level may be  
5   employed as a criteria in a conventional determination  
for determining whether or not the mobile station  
should exit a wait state.

          Previous to the determination process,  
the mobile station may remove, from the selected  
10   candidate zone register, wait disabled levels other  
than that of the control channel (or the overlap  
control channel) in which the mobile station is set up  
for a wait.

          In the foregoing embodiments,  
15   comparison of the measured electric field intensity  
with the wait enabled level is conducted in the  
ascending order of priority assigned to the control  
channels that are specified by the identification  
codes stored in the candidate zone register or the  
20   selected candidate zone register, so that the control  
channel (or the overlap control channel) for which it  
is found that the measured electric field intensity  
exceeds the wait enabled level is selected as the  
control channel in which to wait. Alternatively, the  
25   electric field intensity of the control channels is  
first measured irrespective of the order of priority  
thereof, and then comparisons are made in the  
ascending order of priority.

          Fig. 18 is a flowchart of an operation  
30   of a mobile communication system according to an  
embodiment that corresponds to the invention described  
in claims 13 - 15.

          A description will now be given, with  
reference to Figs. 1 and 17, of an operation of a  
35   mobile communication system according to an embodiment  
that corresponds to the invention described in claim  
13.

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1           The inventive feature of this system  
consists in the measuring process. The other  
processes including the zone entry process are the  
same as the corresponding processes in the embodiments  
5 described so far, and the description thereof is  
omitted.

Those processes of Fig. 18 that are  
identical to the corresponding processes of Fig. 3 are  
designated by the same reference numerals, and the  
10 description thereof is omitted.

Upon a power-on, the control unit  $77_1$   
of the mobile station  $65_1$  measures sequentially the  
electric field intensity  $L_1$  of the control channels  
registered in the control table channel by controlling  
15 the transmission and reception unit  $74_1$  ((1) of Fig.  
18). A determination is then made as to whether or  
not the measured electric field intensity is greater  
than a predetermined threshold level  $L_{th}$  ((2) of Fig.  
18).

20           The control unit  $77_1$  registers the  
control channels for which a determination that the  
measured electric field intensity is greater than the  
threshold level  $L_{th}$  is obtained, in the candidate zone  
register, in relation to the electric field intensity  
25 ((3) of Fig. 18).

The control unit  $77_1$  starts the zone  
entry determination process without measuring the  
electric field intensity of the other control channels  
registered in the control channel table.

30           In those steps of the zone entry  
determination process which steps are started when it  
is found that the format of the announcement  
information differs from the conventional format, all  
the control channels, specified by the identification  
35 information provided in the order of priority or  
provided coupled to information indicating the  
respective order of priority, are subject to the

5                   According to the embodiment described  
above, the time required for the mobile station (65<sub>1</sub> -  
65<sub>N</sub>) to enter a wait state upon a power-on is reduced.  
Therefore, it is ensured that the service can be  
provided promptly upon a power-on or upon an exchange  
10 of a battery.

The difference between this embodiment and the earlier embodiments consists in the measurement process and the zone determination process.

25 In further accordance with this embodiment, when the control unit 77<sub>1</sub> measures the electric field intensity L<sub>2</sub> or L<sub>3</sub> ((7) of Fig. 3, (4) of Fig. 9, (4) of Fig. 11, (4) of Fig. 14 and (4) of Fig. 16), a determination is made as to whether or not  
30 the control channel subject to the measurement is stored in the candidate zone register. If an affirmative answer is given in the determination, the measurement of that control channel is omitted. The electric field intensity already stored in the target  
35 zone register for that control channel is regarded as the electric field intensity L<sub>2</sub> or L<sub>3</sub>.

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1 embodiment, it is possible to reduce the total number  
of control channels to be subjected to the measurement  
of its electric field intensity before the mobile  
station enters a wait state. Therefore, the operating  
5 efficiency of the mobile station is increased and the  
quality of the service is improved.

As shown in Figs. 9, 10, 13 and 15,  
according to the foregoing embodiments, a  
determination as to whether or not the electric field  
10 intensity exceeds the wait enabled level is made for  
the control channels that correspond to all the  
identification codes stored in the selected candidate  
zone register. An alternative approach indicated by  
the chain lines in Figs. 9, 10, 13 and 15 is that upon  
15 a determination that the electric field intensity of  
any channel (radio zone) exceeds the wait enabled  
level, the mobile station immediately is set up for a  
wait in that control channel (radio zone) so that the  
mobile station can receive the communication service.

20 While the identification information  
for overlapping zones adjacent to the radio zone  
formed by a given radio base station is not  
transmitted by the given radio base station, according  
to the foregoing embodiments, the identification  
25 information for the adjacent zones may be transmitted  
as long as the relative orders of priority of the  
adjacent radio zones with respect to the radio zone  
formed by the given radio base station are recognized  
properly by the mobile station.

30 In the foregoing embodiments, various  
information is arranged in the announcement  
information in the ascending order of priority, the  
announcement information is not limited to such a  
construction. For example, the various information  
35 may be arranged in the descending order or in a  
predetermined format corresponding to the order of  
priority.

1           Also, in the foregoing embodiments, the  
announcement information includes the channel numbers  
of the control radio channels assigned to the  
respective radio zones (radio base stations) and used  
5   to transmit the announcement information. However,  
the channel numbers may be replaced by a radio  
frequency in case the radio channel is formed by a  
single radio frequency as in the case of an analog  
mobile communication system, instead of being  
10   constituted according to a time division system such  
as the TDMA system.

          Further, in the foregoing embodiments,  
digital transmission of the announcement information  
is effected by utilizing a spare field not reserved  
15   under a given frame format, the present invention is  
not limited to such a construction. For example, if  
the size of the spare field is not satisfactorily  
large, the announcement information may be transmitted  
in multiframe. The announcement information may be  
20   transmitted in a plurality of frames, either frame by  
frame or in dividends thereof, as long as the mobile  
station can properly receive the announcement  
information.

          While the foregoing embodiments are  
25   constructed such that the announcement information is  
transmitted via the control radio channel, the present  
invention can be applied to various systems  
irrespective of the radio channel setting control  
method and the radio transmission method.

30           Reference is made to Fig. 20 and a  
description will now be given of embodiments of the  
invention directed to resolving the second aspect of  
the problem with the conventional mobile communication  
system. According to the invention described below,  
35   each of a plurality of base stations forming  
overlapping zones and constituting a mobile  
communication system is assigned an order of priority.

35                   A request for a message channel  
issued by the mobile station originating a call or  
receiving a call is received by the

The transmission/reception unit 101 corresponds to a transmission/reception unit 306 shown in Fig. 19 illustrating the principle of the present invention directed to resolving the second aspect of the problem with the conventional mobile communication system. The control unit 102 corresponds to a data control unit 307 shown in Fig. 19. The description of the transmission/reception unit 306 and the data control unit 307 will be given later.

35           A request for a message channel  
occurring when a call is originated or when a call is  
received is transmitted to the TDMA circuit 504 under

1 the control of the control unit 502. The request is  
processed by the TDMA circuit 504 and then modulated  
by the modulator 510. The modulated request is  
transmitted to the target base station via the common  
5 antenna 507 and the antenna 506.

The transmission/reception unit 501  
corresponds to an announcement information receiving  
unit 309 and a transmission unit 310 described later.  
The control unit 502 corresponds to a message channel  
10 control unit 308, an announcement information storage  
unit 311 and a reception level measuring unit 312  
described later.

Fig. 19 illustrates the principle of  
the present invention directed to resolving the second  
15 aspect of the problem with the conventional mobile  
communication system. The base station 201 includes  
the data control unit 307 and the  
transmission/reception unit 306. The base station 201  
transmits announcement information to mobile stations  
20 and assigns a message channel to a requesting mobile  
station.

The data control unit 307 manages and  
controls the order of priority assigned to the base  
station 201 and other base stations associated with  
25 the base stations 201. The data control unit 307 also  
controls assignment of a message channel responsive to  
a request for a message channel from a mobile station,  
so as to set up a call. A request for a message  
channel could occur when switching from one message  
30 channel to another occurs during a communication. A  
request for a message channel could also occur when a  
mobile station originates a call or receives a call.  
The transmission/reception unit 306 provides an  
interface for all the signals controlled by the data  
35 control unit 307. The base stations 202, 203 and 204  
have the same construction and function the same way  
as the base station 201 so that the description

1       thereof is omitted.

                  Referring again to Fig. 19, a mobile  
station 205 comprises the message channel control unit  
308, the announcement information receiving unit 309,  
5       the transmission unit 310, the announcement  
information storage unit 311 and the reception level  
measuring unit 312.

                  The message channel control unit 308  
operates to select a base station to which a request  
10       for a message channel is to be issued, based on the  
order of priority of the base stations included in the  
announcement information from the base station (one of  
the base stations 201, 202, 203 and 204), and based on  
the reception level in the perch channels provided for  
15       the respective base stations (the base stations 201,  
202, 203 and 204). The announcement information  
receiving unit 309 operates to receive the  
announcement information from the base station. The  
transmission unit 310 operates to transmit a request  
20       for a message channel to the base station selected by  
the message channel control unit 308. The  
announcement information storage unit 311 stores the  
announcement information received by the announcement  
information receiving unit 309. The reception level  
25       measuring unit 312 reads the announcement information  
stored in the announcement information storage unit  
311 when a request for a message channel is issued to  
the base station, and measures the reception level of  
the perch channels provided for the respective base  
30       stations in the descending order of priority such that  
the reception level in the perch channel having the  
highest priority is measured first. The reception  
level measuring unit 312 transmits the measured  
reception level to the message channel control unit  
35       308.

                  Figs. 21A and 21B illustrate the  
principle according to which a mobile station issues a



1 request for a message channel to a base station in the  
mobile communication system of Fig. 19. Fig. 21A  
shows how the announcement information is delivered,  
and Fig. 21B shows the principle of the flow of the  
5 call origination operation according to the present  
invention.

An outline of the call request  
operation according to the present invention will now  
be given. It is assumed that the mobile station 205  
10 is located in the service area formed by the base  
station 204 but is set up for a wait in the base  
station 201. When the mobile station 205 issues a  
call, the reception level measuring unit 312 of the  
mobile station 205 measures the reception level of the  
15 base stations 201, 202, 203 and 204 and determines  
that the announcement information is to be received  
from, for example, the base station 201 that provides  
the highest reception level. It is assumed that the  
reception levels measured by the reception level  
20 measuring unit 312 are such that the base station 201,  
the base station 202, the base station 203, the base  
station 204 and the base station 202 have increasingly  
lower reception levels in the stated order.

When the transmission/reception unit  
25 306 of the base station 201 transmits the announcement  
information managed by the data control unit 307, the  
announcement information receiving unit 307 of the  
mobile station 205 stores the received announcement  
information in the announcement information storage  
30 unit 311. The announcement information transmitted by  
the base station could have the format as shown in  
Fig. 22, Fig. 23 or Fig. 24. The announcement  
information having the format of Fig. 22 includes the  
order of priority assigned to the base station  
35 transmitting the announcement information. The format  
shown in Fig. 23 is such that the perch channel codes  
corresponding to the base station which is the source

The reception level measuring unit 312 of the mobile station originating a call measures the reception level of the perch channels provided for the base stations, in the descending order of the priority based on order of priority specified in the announcement information from the base station (step S1). The reception level measuring unit 312 transmits the reception level to the message channel control unit 308. It is assumed that the order of priority is such that the base station 204, the base station 203, the base station 201 and the base station 202 have increasingly lower priorities in the stated order.

20           Once the reception level in the perch  
channel corresponding to the base station 204 is  
received, the message channel control unit 308  
determines that a request for a message channel is to  
be issued to the base station 204 if the measured  
25   reception level is equal to or exceeds a predetermined  
threshold level. The message channel control unit 308  
then issues a request for a message channel to the  
base station 204 via the transmission unit 310 (S2).

A detailed description of call origination outlined above will now be given. Fig. 25 is a flowchart showing the flow of the call origination operation, and Fig. 26 shows a sequence of the call origination operation.

35       The reception level measuring unit 312  
of the mobile station 205 measures the reception level  
provided by the base stations (the base stations 201,  
202, 203 and 204) forming the respective zones (steps

Upon receipt of the announcement

information from the base station 201 (S205), the announcement information receiving unit 309 of the mobile station 205 causes the announcement information to be stored in the announcement information storage unit 311. The announcement information could have the format as shown in Fig. 22, Fig. 23 or Fig. 24. The announcement information having the format of Fig. 22 includes the order of priority assigned to the base station transmitting the announcement information. When the mobile station 205 receives the announcement information having the format as shown in Fig. 22, the mobile station 205 needs to acquire the announcement information from the base stations other than the source base station (the base station 201) that transmitted the announcement information, in order to learn the order of priority assigned to the base stations adjacent to the source base station. The format shown in Fig. 23 is such that the perch channel codes corresponding to the source base station and the adjacent base stations are arranged in the descending order (or the ascending order) of the priority. The format shown in Fig. 24 is such that each of the perch channels codes corresponding to the source base stations and the adjacent base stations is coupled to the associated order of priority. It will now be assumed that the mobile station 205 has received the announcement information having the format of Fig. 23.

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The reception level measuring unit 312 transmits the measured reception level to the message channel control unit 308. The message channel control unit 308 determines whether the level is equal to or exceeds a predetermined threshold level that enables a request for a message channel. If it is determined that level is equal to or exceeds the threshold level, the mobile station acquires the announcement information from the base station 204 (S207). If it is determined that the level is below the threshold level, the reception level measuring unit 312 measures the reception level of the perch channel corresponding to the base station 203 having the next highest order of priority (S206). The reception level measuring unit 312 repeats step S206 such that it successively measures the reception level of the perch channel provided for the respective base stations in the

1 descending order of priority, until the base station  
that provides the reception level which is equal to or  
exceeds the threshold level is found, or until all the  
perch channels are subject to measurement.

5 When the user of the mobile station 205  
performs an operation for originating a call (S208 in  
Fig. 26 and S101 in Fig. 25) after S207, the message  
channel control unit 308 determines whether the  
announcement information from the base station 204  
10 contains the order of priority of the base stations  
(base stations 201, 202, 203 and 204) (S102).

When the announcement information  
contains the order of priority (YES in S102) of the  
base stations 201, 202, 203 and 204, the reception  
15 level measuring unit 312 reads the announcement  
information from the announcement information storage  
unit 311 so as to retrieve the order of priority  
assigned to the perch channels which are provided for  
the base stations 201, 202, 203 and 204. The  
20 reception level measuring unit 312 measures the  
reception level of the perch channel corresponding to  
the base station 204 having the highest priority. The  
order of priority stored in the announcement  
information storage unit 311 is such that the base  
25 station 202 < the base station 201 < the base station  
203 < the base station 204.

The reception level measuring unit 312  
transmits the reception level in the perch channel  
corresponding to the base station 204 to the message  
30 channel control unit 308. The message channel control  
unit 308 determines whether the reception level is  
equal to or exceeds a predetermined threshold level  
that enables a request for a message channel (S103).  
If the message channel control unit 308 determines  
35 that the reception level is equal to exceeds the  
threshold level (YES in S103), the message channel  
control unit 308 retrieves restriction information

1 from the announcement information transmitted from the  
base station 204 and stored in the announcement  
information storage unit 311. The message channel  
control unit 308 determines whether it is possible to  
5 originate a call in a zone 224 (see Fig. 20).

If the message channel control unit 308  
determines in step S103 that the reception level is  
below the threshold level (NO in S103), the reception  
level measuring unit 312 determines whether a perch  
10 channel corresponding to the base station having the  
next highest priority is available (S104). If no  
perch channel corresponding to the base station having  
the next highest priority is available (NO in S104),  
it is determined that the mobile station 205 cannot  
15 originate a call (S105) and is put in a wait state  
(S106). If a perch channel corresponding to the base  
station having the next highest priority is available  
(YES in S104), the reception level measuring unit 312  
repeats steps S104 and S107 such that it successively  
20 measures (NO in S107) the reception level in the perch  
channels in the descending order of priority until the  
base station providing a reception level which is  
equal to or exceeds the threshold level is found (YES  
in S107) or until all the perch channels have been  
25 subject to measurement (NO in S104). If the message  
channel control unit 308 finds a base station that  
provides a reception level which is equal to or  
exceeds the threshold level (YES in S107), the message  
channel control unit 308 retrieves the restriction  
30 information from the announcement information stored  
in the announcement information storage unit 311 so as  
to determine if it is possible to originate a call in  
the zone formed by the base station found in S107  
(S108). If it is determined that the order of  
35 priority of the base stations is not included in the  
announcement information (NO in S102), the message  
channel control unit 308 retrieves the restriction

1 information from the announcement information stored  
in the announcement information storage unit 311 and  
determines whether it is possible to originate a call  
in the zone formed by the base station which is the  
5 source of the stored announcement information (S108).

If it is determined that call  
origination is disabled in the zone 224 formed by the  
base station 204 (NO in S108), the mobile station 205  
is put in a wait state (S109). If call origination is  
10 enabled (YES in S108), the message channel control  
unit 308 retrieves the restriction information from  
the announcement information stored in the  
announcement information storage unit 311 so as to  
determine whether a restriction regarding a preferred  
15 mobile station is imposed on the zone 224 formed by  
the base station 204 (S110). A preferred mobile  
station is a station which is given a precedence in  
message channel assignment.

If it is determined that a restriction  
20 regarding a preferred mobile station is imposed (YES  
in S110) and if the mobile station 205 is a preferred  
mobile station (YES in S111), the message channel  
control unit 308 determines whether call origination  
in the mobile station 205 is enabled (S112). If it is  
25 determined that call origination is enabled (YES in  
S112), the message channel control unit 308 determines  
that a request for a message channel is to be issued  
to the base station 204 and causes the transmission  
unit 310 to transmit a request for a message channel  
30 (S209). If it is determined that call origination is  
disabled (NO in S112), the mobile station 205 is put  
in a wait state (S113).

If a restriction regarding a preferred  
mobile station is imposed (YES in S110) and if the  
35 mobile station 205 is not a preferred mobile station  
(NO in S111), the message channel control unit 308  
determines whether a restriction is imposed on the

1 mobile station 205 (S114). If there is no restriction  
(NO in S114), the message channel control unit 308  
determines that a request for a message channel is to  
be issued to the base station 204 and causes the  
5 transmission unit 310 to transmit a request for a  
message channel to the base station 204 (S209). If  
there is a restriction (YES in S114), the mobile  
station 205 is put in a wait state (S115).

If it is determined that no restriction  
10 regarding a preferred mobile station is imposed (NO in  
S110), the message channel control unit 308 determines  
that a request for a message channel is to be issued  
to the base station 204 and causes the transmission  
unit 310 to transmit a request for a message channel  
15 (S209).

When an unused message channel is  
available in the base station 204 receiving the  
request for a message channel, the base station 204  
assigns a message channel to the mobile station 205  
20 and transmits a channel assignment signal to the  
mobile station (S210). When there is no message  
channel available, the base station 204 notifies the  
mobile station 205 that there is no message channel  
available, thus putting the mobile station in a wait  
25 state.

The mobile station 205 that has  
received the channel assignment signal originates a  
call to another mobile station (S116) and establishes  
the assigned message channel with the base station 204  
30 so as to start a call.

Referring to Fig. 20, a detailed  
description will now be given of how a call incoming  
to the mobile station 205 located in the service area  
formed by the base station 203 and set up for a wait  
35 in the base station 201 is processed according to the  
mobile communication system of the present invention.  
Reference is also made to Fig. 27, which shows the



1 flow of the call-incoming operation according to the  
present invention, and Fig. 28, which shows the  
sequence of the call-incoming operation.

5 The reception level measuring unit 312  
of the mobile station 205 measures the reception level  
provided by the base stations 201, 202, 203 and 204  
forming the respective zones (steps S401, S402, S403  
and S404 in Fig. 28). It is assumed that the  
reception levels provided by the base stations 201,  
10 202, 203 and 204 are such that the base station 202 <  
the base station 204 < the base station 203 < the base  
station 201, so that the message channel control unit  
308 determines that the announcement information is to  
be received from the base station 201 providing the  
15 highest reception level.

20 The mobile station 205 has received the  
announcement information from the base station 201  
(S405), the announcement information receiving unit  
309 causes the announcement information to be stored  
in the announcement information storage unit 311. The  
announcement information could have the format as  
shown in Fig. 22, Fig. 23 or Fig. 24. The  
announcement information having the format of Fig. 22  
includes the order of priority assigned to the base  
25 station transmitting the announcement information.  
When the mobile station 205 receives the announcement  
information having the format as shown in Fig. 22, the  
mobile station 205 needs to acquire the announcement  
information from the base stations other than the  
30 source base station (the base station 201) that  
transmitted the announcement information, in order to  
learn the order of priority assigned to the base  
stations adjacent to the source base station. The  
format shown in Fig. 23 is such that the perch channel  
35 codes corresponding to the source base station and the  
adjacent base stations are arranged in the descending  
order (or the ascending order) of the priority. The

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1 format shown in Fig. 24 is such that each of the perch  
channels code corresponding to the source base  
stations and the adjacent base stations is coupled to  
the associated order of priority. It will now be  
5 assumed that the mobile station 205 has received the  
announcement information having the format of Fig. 23.

The message channel control unit 308  
reads the announcement information from the  
announcement information storage unit 311 so as to  
10 learn the order of priority assigned to the base  
stations (the base stations 201, 202, 203 and 204) and  
a predetermined level of the reception level that  
enables a request for a message channel. It is  
assumed that the base station 202, the base station  
15 204, the base station 201 and the base station 203  
have the increasingly higher priorities. The  
reception level measuring unit 312 reads the  
announcement information from the announcement  
information storage unit 311 so as to retrieve the  
20 order of priority included in the announcement  
information to be assigned to the respective perch  
channels codes, each of the perch channel codes  
corresponding to the associated base station. The  
reception level measuring unit 312 then measures the  
25 reception level of the perch channel corresponding to  
the base station 203 having the highest priority  
(S406).

The reception level measuring unit 312  
transmits the measured reception level to the message  
30 channel control unit 308. The message channel control  
unit 308 then determines whether the level is equal to  
or exceeds a predetermined threshold level that  
enables a request for a message channel. If the  
message channel control unit 308 determines that the  
35 level is equal to or exceeds the threshold level, the  
mobile station 205 acquires the announcement  
information from the base station 203 (S407). The

1 message channel control unit 308 obtains the order of  
priority of the base stations 201, 202, 203 and 204  
from the announcement information from the base  
station 203. If the message channel control unit 308  
5 determines that the level is below the threshold  
level, the reception level measuring unit 312 measures  
the reception level of the perch channel corresponding  
to the base station 204 given the next highest  
priority (S406). The reception level measuring unit  
10 312 repeats step S406 such that it successively  
measures the reception level in the perch channels in  
the descending order of priority until the base  
station providing a reception level which is equal to  
or exceeds the threshold level is found or until all  
15 the perch channels have been subject to measurement.

When there is an incoming call in the  
mobile station 205 after S407 (S408, S409, S410, S411)  
(S301 in Fig. 27), and when the order of priority of  
the base stations 201, 202, 203 and 204 is included in  
20 the announcement information (YES in S302), the  
reception level measuring unit 312 reads the  
announcement information from the announcement  
information storage unit 311 so as to retrieve the  
order of priority of the base stations 201, 202, 203  
25 and 204, the order of priority being indicated by  
information assigned to each of the perch channels  
corresponding to the respective base stations 201,  
202, 203 and 204. The reception level measuring unit  
312 measures the reception level of the perch channel  
30 corresponding to the base station 203 having the  
highest priority. The order of priority stored in the  
announcement information storage unit 312 is such that  
the base station 201 < the base station 204 < the base  
station 201 < the base station 203.

35 The reception level measuring unit 312  
transmits the reception level of the perch channel  
corresponding to the base station 203 to the message

1 channel control unit 308. The message channel control  
unit 308 determines whether the reception level is  
equal to or exceeds a predetermined threshold level  
that enables a request for a message channel (S303).  
5 If the message channel control unit 308 determines  
that the reception level is equal to or exceeds the  
threshold level (YES in S303), the message channel  
control unit 308 retrieves restriction information  
from the announcement information transmitted from the  
10 base station 203 and stored in the announcement  
information storage unit 311 so as to determine  
whether call incoming is enabled in the zone 223  
formed by the base station 203 (S308).

If the message channel control unit 308  
15 determines in S303 that the reception level is below  
the threshold level (NO in S303), the reception level  
measuring unit 312 determines whether the base station  
having the next highest priority is available (S304).  
If no perch channel corresponding to the base station  
20 having the next highest priority is available (NO in  
S304), call incoming in the mobile station 205 is  
disabled (S305) so that the mobile station 205 is put  
in a wait state (S306). If the perch channel  
corresponding to the base station having the next  
25 highest priority is available (YES in S304), the  
reception level measuring unit 312 repeats steps S304  
and S307 such that it successively measures (NO in  
S307) the reception level in the perch channels in the  
descending order of priority until the base station  
30 providing a reception level which is equal to or  
exceeds the threshold level is found (YES in S307) or  
until all the perch channels have been subject to  
measurement (NO in S304). If the message channel  
control unit 308 finds a base station that provides a  
35 reception level which is equal to or exceeds the  
threshold level (YES in S307), the message channel  
control unit 308 retrieves the restriction information

1 from the announcement information stored in the  
announcement information storage unit 311 so as to  
determine if call incoming is enabled in the zone  
formed by the base station found in S307 (S308). If  
5 it is determined in S302 that the order of priority of  
the base stations is not included in the announcement  
information (NO in S302), the message channel control  
unit 308 retrieves the restriction information from  
the announcement information stored in the  
10 announcement information storage unit 311 and  
determines whether call incoming is enabled in the  
zone formed by the base station which is the source of  
the stored announcement information (S308).

If it is determined that call incoming  
15 is disabled in the zone 223 formed by the base station  
203 (NO in S303), the reception level measuring unit  
312 determines whether the perch channel corresponding  
to the base station having the next highest priority  
is available (S304). If no perch channel  
20 corresponding to the base station having the next  
highest priority is available (NO in S304), call  
incoming in the mobile station 205 is disabled (S305)  
so that the mobile station 205 is put in a wait state  
(S306). If the perch channel corresponding to the  
25 base station having the next highest priority is  
available (YES in S304), the reception level measuring  
unit 312 repeats steps S304 and S307 such that it  
successively measures (NO in S307) the reception level  
in the perch channels in the descending order of  
30 priority until the base station providing a reception  
level which is equal to or exceeds the threshold level  
is found (YES in S307) or until all the perch channels  
have been subject to measurement (NO in S304). If the  
message channel control unit 308 finds a base station  
35 that provides a reception level which is equal to or  
exceeds the threshold level (YES in S307), the message  
channel control unit 308 retrieves the restriction

1 information from the announcement information stored  
in the announcement information storage unit 311 so as  
to determine if call incoming is enabled in the zone  
formed by the base station found in S307 (S308).

5 If it is determined that call incoming  
is enabled in the zone 223 formed by the base station  
203 (YES in S308), the message channel control unit  
308 retrieves the restriction information from the  
announcement information transmitted from the base  
10 station 203 and stored in the announcement information  
storage unit 311 so as to determine whether a  
restriction regarding a preferred mobile station is  
imposed in the zone 223 formed by the base station 203  
(S309).

15 If there is a restriction regarding a  
preferred mobile station (YES in S309) and if the  
mobile station 205 is a preferred mobile station (YES  
in S310), the message channel control unit 308  
determines whether call incoming is enabled in the  
20 mobile station 205 (S311). If call incoming is  
enabled (YES in S311), the message channel control  
unit 308 determines that a request for a message  
channel is to be issued to the base station 203 and  
causes the transmission unit 310 to transmit a request  
25 for a message channel (S412). If call incoming is  
disabled (NO in S311), the mobile station 205 is put  
in a wait state (S312).

If there is a restriction regarding a  
preferred mobile station (YES in S309) and if the  
30 mobile station 205 is not a preferred mobile station  
(NO in S310), the message channel control unit 308  
determines whether a restriction is imposed on the  
mobile station 205 (S313). If there is no restriction  
(NO in S313), the message channel control unit 308  
35 determines that a request for a message channel is to  
be issued to the base station 203 and causes the  
transmission unit 310 to transmit a request for a

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1 message channel (S412). If there is a restriction  
(YES in S313), the mobile station 205 is put in a wait  
state (S314).

If it is determined that there is no  
5 restriction regarding a preferred mobile station (NO  
in S309), the message channel control unit 308  
determines that a request for a message channel is to  
be issued to the base station 203 and causes the  
transmission unit 310 to transmit a request for a  
10 message channel (S412).

The base station 203 receiving the  
request assigns an unused message channel to the  
mobile station 205 and transmits a channel assignment  
signal thereto (S413). If no unused message channel  
15 is available, the mobile station 205 is put in a wait  
state.

The mobile station receiving the  
message channel assignment signal returns a response  
to an incoming call to the base station 203 (S309),  
20 establishes the assigned message channel with the base  
station 203 so as to start a call (S414).

Referring to Fig. 20, a detailed  
description will now be given of how a switching from  
one message channel to another is performed in the  
25 event of a handover. It is assumed that the mobile  
station 205 is located in the service area formed by  
the base station 201 and making a call via the base  
station 201. Fig. 29 shows the flow of a recall  
channel switching operation, and Fig. 30 shows the  
30 sequence of the recall channel switching operation.  
The message channel switching performed when a  
handover occurs during a conversation is also  
performed when there is a drop in the reception  
quality.

35 It is assumed that, while the mobile  
station 205 is communicating with another mobile station by  
establishing a message channel with the base station

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If it is determined that the order of  
15 priority of the base stations 201, 202, 203 and 204 is  
included in the announcement information (YES in  
S502), the reception level measuring unit 312 reads  
the announcement information from the announcement  
information storage unit 311 so as to retrieve the  
20 order of priority of the base stations 201, 202, 203  
and 204 corresponding to the perch channel codes  
included in the announcement information having the  
format of, for example, Fig. 23. The reception level  
measuring unit 312 measures the reception level in the  
25 perch channel corresponding to the base station 204  
assigned the next highest priority (S603).

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5           If the message channel control unit 308  
determines that the reception level is below the  
threshold level (NO in S503), the reception level  
measuring unit 312 determines whether the perch  
channel corresponding to the base station having the  
10 next highest priority next to the base station 204 is  
available (S504). If no perch channel corresponding  
to the base station having the next highest priority  
is available (NO in S504), message channel switching  
in the mobile station 205 is disabled (S505). In this  
15 case, the mobile station 205 is disconnected or  
switched back to the base station 201 (S506). If a  
perch channel corresponding to the base station having  
the next highest priority next to the base station 204  
is available (YES in S504), the reception level  
20 measuring unit 312 repeats steps S504 and S507 such  
that it successively measures (NO in S307) the  
reception level in the perch channels in the  
descending order of priority until the base station  
providing a reception level which is equal to or  
25 exceeds the threshold level is found (YES in S507) or  
until all the perch channels have been subject to  
measurement (NO in S504). If the message channel  
control unit 308 finds a base station that provides a  
reception level which is equal to or exceeds the  
30 threshold level (YES in S507), the message channel  
control unit 308 retrieves the restriction information  
from the announcement information stored in the  
announcement information storage unit 311 so as to  
determine if recall is enabled in the zone formed by  
35 the base station found in S507 (S508). If it is  
determined that the order of priority of the base  
stations is not included in the announcement

1 information (NO in S502), the message channel control  
unit 308 retrieves the restriction information from  
the announcement information stored in the  
announcement information storage unit 311 so as to  
5 determine whether recall is enabled in the zone formed  
by the base station which is the source of the stored  
announcement information (S508).

If it is determined that recall is  
disabled in the zone 224 formed by the base station  
10 224 (NO in S504), message channel switching is  
disabled in the mobile station 205 so that the mobile  
station 205 is disconnected (S509). If recall is  
disabled (YES in S508), the message channel control  
unit 308 retrieves the restriction information from  
15 the announcement information transmitted from the base  
station 204 and stored in the announcement information  
storage unit 311 so as to determine whether a  
restriction regarding a preferred mobile station is  
imposed in the zone 224 formed by the base station 204  
20 (S510).

If there is a restriction regarding a  
preferred mobile station (YES in S510) and if the  
mobile station 205 is a preferred mobile station (YES  
in S511), the message channel control unit 308  
25 determines whether recall is enabled in the mobile  
station 205 (S512). If it is determined that recall  
is enabled (YES in S512), the message channel control  
unit 308 determines that a request for a message  
channel is to be issued to the base station 204 and  
30 causes the transmission unit 310 to transmit a request  
for a message channel (S604). If recall is disabled  
(NO in S512), message channel switching in the mobile  
station 205 is disabled so that the mobile station 205  
is disconnected (S513).

35 If there is a restriction regarding a  
preferred mobile station (YES in S510) and if the  
mobile station 205 is not a preferred mobile station

1 (NO in S511), the message channel control unit 308  
determines whether a restriction is imposed on the  
mobile station 205 (S514). If there is no restriction  
(NO in S514), the message channel control unit 308  
5 determines that a request for a communication is to be  
issued to the base station 204 and causes the  
transmission unit 310 to transmit a request for a  
message channel (S604). If there is a restriction  
(YES in S514), message channel switching in the mobile  
10 station 205 is disabled so that the mobile station 205  
is disconnected (S515).

If it is determined that no restriction  
regarding a preferred mobile station is imposed (NO in  
S510), the message channel control unit 308 determines  
15 that a request for a message channel is to be issued  
to the base station 204 and causes the transmission  
unit 310 to transmit a request for a message channel  
(S604) (S516).

The base station 204 receiving the  
20 request assigns an unused message channel to the  
mobile station 205 and transmits a channel assignment  
signal thereto (S605). If no unused message channel  
is available, the mobile station 205 is disconnected.

The mobile station receiving the  
25 message channel assignment signal establishes the  
assigned message channel with the base station 204 so  
as to continue a call (S606).

As described above, the present  
invention as applied to a mobile communication system  
30 having a hierarchical zone construction enables a  
mobile station to issue a request for a message  
channel to a base station that forms a smaller zone  
and provides a lower reception level, instead of a  
base station that forms a larger zone and provides a  
35 higher reception level. The present invention  
accomplishes such an arrangement by including in the  
announcement information the order of priority

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1 assigned to each of the base stations constituting the  
hierarchical zone construction.

The present invention is not limited to the above described embodiments, and variations and  
5 modifications may be made without departing from the scope of the present invention.

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